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Monitoring wetlands deterioration in the Cameroon coastal lowlands: implications for management

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Abstract

The problems of coastal wetlands hazards and management are increasingly apparent in the face of rapid population growth in coastal zones worldwide. This has significantly heightened scientific interest in spatio-temporal analysis of the Global Environmental Change (GEC) effects in the coastal zones, particularly of the sandy, swampy depositional coastal environment characteristic of the humid tropical coasts. Evolved with massive sedimentation of the Holocene period which saw the drowning of the mouths of coastal rivers along the humid tropical coastlines, the Cameroon costal lowlands of interest in this paper describes extensive wetlands from the Limbe area to the west and the Douala area to the east, which today is characterized by a lagoon system. This locality is easily the most rapidly urbanized area in Cameroon witnessing extensive spatial expansion in the Limbe, Tiko and Douala areas, which has provoked certain observable environmental problems with the conversion of the wetlands, The area now suffer in form of poor land reclamation practices, highway construction, impaired water quality, dismal domestic sewage disposal, heavy effluent discharge, subsidence etc. This paper utilizes the opportunity offered by remote sensing tools to monitor the wetlands over space and time to cover regional and micro scales. SLAR (Side Looking Airborne Radar) imagery permits quick and accurate mapping of coastline detail, while coverage of changing patterns of features over space and time is enhanced for management implications.

Keywords: wetlands deterioration; monitoring; management; coastal zone

1. Introduction

Wetlands deterioration and loss in a predominantly aquatic terrain in the face of increasing human population provokes a series of environmental and socio-economic distortions. These distortions are easily observable as impairing developmental processes particularly in the less developed countries of the world. The sub-Saharan countries are particularly vulnerable to such detrimental impacts as their coastal wetlands continue to witness deterioration in quality and their services. The freshwater ecosystems that the coastal wetlands of the humid tropical coast type characteristic of the west and central African coast have remained essential components of the environment here as they provide support for the existence of aquatic and terrestrial wildlife, environmental goods for the supply of water, foods in essential protein sources and services as flood attenuation, depletion of organic pollution. The low-lying, swampy coast type of the Cameroon coastal lowlands ensure dynamic processes of marine transgressions and its associated factors such as variations in sediment deposition, period of inundation, salinity ranges and storm surge

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and incursions. The dominant silt-composition of sediments accumulating in the tidal inlets of the evolved lagoon-creek system creates salt marshes, which has transformed this rainforest subtype into a rich wetland ecological zone. These wetlands of Cameroon are characterized by a largely homogenous vegetation type of the different species of the mangrove.

The Cameroon coastal lowlands form part of a wider geologic environment describing the sedimentary basin evolved from extensive and intensive work of deep chemical weathering and fluvial activities. The evolution of the Cameroon coastal lowlands has been influenced by the massive chain of the Cameroon volcanic line where deeply weathered materials of the migmatite rocks consisting of granite, gneisses are moved and liberated as ferruginous materials through fluvial activities of the four main rivers of the Mungo, Wouri, Dibamba and Sanaga. These rivers have actively carried out depositional activities in their lower courses, thus evolving the sedimentary basin of the Cameroon coastal lowlands. With the retreat of the Atlantic Ocean where these coastal rivers enter the sea, which took the form of marine regressions of the Tertiary to Early Quaternary, particularly of the Holocene, a period of sedimentation occurred with the drowning of the lower courses of the estuarine systems of these rivers. Rivers Mungo, Wouri, Dibamba and Sanaga have several kilometers of their lower courses as inland extensions of the lagoons, creeks and wetlands which they feed. The geomorphic implication is that the Cameroon coastal lowlands are today dominated by a broad embayment in the rapidly urbanized area of Douala as it opens into the Atlantic Ocean and this greatly enhances tidal movements with constant saline water incursions.

2. The problem

Coastal wetlands are low-lying areas that constitute the interface between terrestrial and aquatic ecosystems. Their water tables are characteristically at, near or above the land surface for a significant period of the year (Asangwe, 1996). In the Cameroon coastal lowlands, the wetlands are essentially marine, lagoonal and estuarine, emphasizing the strong influence of tidal actions along the Gulf of Guinea. The low-lying nature of the Cameroon coastal lowlands between Douala and Tiko ensure that inundation remains a constant threat expected to get worse with accelerated sea level rise. A direct consequence is the continued loss of wetlands dominated in the Cameroon coastal lowlands by the mangrove forest vegetation. Salinisation of soils and groundwater is already a huge problem in the Douala-Edea-Kribi area to the east and the Douala-Tiko area to the west of the depositional sedimentary basin of the Cameroon coastal lowlands. The Cameroon coastal lowlands are flood-tide dominated where wetlands dominated by mangroves proliferate within the shoaling lagoons, creeks and tidal inlets. This is thus a geomorphologically fragile zone of instability which presently comes under intense human-induced actions which has seen alteration in the hydro-geomorphic characteristics of the area over time. In an area where the crucial problem of abundance of surface water as wetlands is faced with scarcity of land, the continued challenge of instability is made worse with the increased human population. Increasing intrusion of salt water into the shallow aquifers of this coastal area is at greater risks to the teeming human population as urban spatial growth continue unabated and uncontrolled. The rapidly urbanized cities of Douala, Limbe and Tiko now inflict large scale environmental problems in this land-water interface, with uncoordinated wetland conversion. The consequences of which now provokes hazards such as flooding, wetland loss, ecological stress, contamination and depletion of surface and groundwater resources amongst others.

3. Issues of wetland deterioration and loss

The configuration of the Cameroon coastal lowlands between Limbe and Douala describes extensive spatial coverage of wetlands perennially influenced by inundation and flooding. The wetlands here display the typical tropical wetlands of pronounced hydrologic and edaphic variability where tidal rather seasonal flooding regimes occur and where brackish rather than freshwaters prevail. Tropical wetlands are increasingly being seen as a vegetation formation in their own right, although neither their overall extent, nor their level of human disturbance is accurately known (Barbier, 1993). Broad estimates suggest some 264 million hectares of wetland exist in the tropics, occupying 4.8% of the land area (Mitsch and Gosselink, 1993). The mangrove forest vegetation constitutes the dominant wetland ecosystem of the humid tropical coast of Cameroon that is currently subjected to considerable human-induced changes. The human-induced actions cover wetlands conversion for housing, industrial development, expansion of highways etc., while natural changes are inflicted by salt water intrusion, subsidence.

The combination of these changes have resulted in vegetation stress and wetland deterioration of substantial magnitude in the Cameroon coastal habitats including saltmarshes, brackish and freshwater marshes, and the predominantly mangrove forests. The consequences are a net loss of these resources. The vulnerability of the coastal habitats of Cameroon is seen in the ecological disruptions inflicted on the wetlands with far reaching socio-economic implications. Management of these fragile wetlands ecosystem has been increasingly difficult in the face of undue and excessive interference resulting in physical deterioration observed in the coastal lowlands of the Douala and Tiko areas of Cameroon. The natural land-water ecosystem of the wetlands has therefore been unduly manipulated in spite of the restrictions imposed by the aquatic terrain. It is certain that the rate of interference would continue with increased human population and the resultant rapid urbanization.

3.1. Wetlands reclamation

The most easily observable interference on the wetlands of the Cameroon coastal zone is the process of wetlands conversion into reclaimed land. Reclamation has always been considered as a suitable means of providing the requisite dry land for urban expansion. The need for such land became even more considerable and continuing, given the rapid population growth rate. This explains why the Douala metropolitan area has witnessed the most extensive Land reclamation projects within the last five decades. Douala is easily the most urbanized city in Cameroon and its large scale land reclamation projects started with the construction of the bridge over the River Wouori linking the Douala city center with the hinterland into the North West, South West and West regions. This initial reclamation of wetlands around the tidal flats and the lagoon-creek system of the River Wouri estuary was undertaken by the French colonial administration and this involved the displacement of surface water by hydraulic sand filling. The exercise was so massive that it did not only provided solid grounds for the construction of the bridge, but it converted more land for economic purposes of harbour facilities, industrial estates, energy and power plants. The hydraulic sand filing locality to the north of Douala provided an estimated 20% of additional land of the drier barrier islands formations on which the city grew. This public reclamation schemes have seen the construction of the dual carriage road highway out of Douala into the Bonaberi district, the government industrial complex known as MAGZI, energy storage depot, the National ship yard company, a military Naval base and the port handling facilities of the Douala harbour.

With the rapid population growth and associated land pressure, the extensive wetlands of the Cameroon coastal lowlands has been seen over time as a constraint to urban development. Consequently away from the government reclamation projects, small-scale private reclamation of swamps and mudflats took an unprecedented rate involving poor reclamation practices. The intense competition for land resulted in haphazard encroachment into the wetlands utilizing domestic refuse, organic and inorganic residue, poorly sorted volcanic materials, sand and clay as in-fill. The problem here is that inadequate drying out and compaction of the in-fill materials is generally widespread in the entire area, an almost immediately building construction commences. The displacement of the surface water is largely premature and highly ineffective resulting in large scale environment disturbing scenarios over the area.

3.2. Wetlands utilization

The landform features of this depositional landscape has been decisively influenced by the humid climate, estuarine systems of the Rivers Mungo and Wouri, low relief, infertile soils and dense wetland vegetation.

As a result of the relationship between the geomorphic attributes of the habitat and its natural vegetation, the wetlands of the Cameroon coastal lowlands have traditionally acted as reservoirs for excess surface run-off and have served to limit coastal flooding. They have also acted as natural sieves that filter out and absorb sediments and organic matter brought by surface run-off to the coastal zone. They have thus protected water quality by removing pollutants, and also recharged aquifers as observed in the older settled areas where boreholes have been dug for water supply.

The coastal wetlands of Cameroon under the direct influence of estuarine, lagoon and marine physical complexities creates an environment that is diverse and distinctive in biological terms. In many respects, the area has a high natural resource potential, but remains vulnerable to human interference and prone to degradation. Direct human interference in wetlands utilization in this area is sourcing for fuel, fishing and human settlement. These are all deliberate actions where wetlands are commonly perceived as waste lands and as hazards to health that should be

used more productively.

4. Methods

Spatial assessment of landuse and landcover attributes over the wetlands in the study area between Tiko and Douala were obtained from the 1:500000 topographic map of Buea-Douala of 1976 as the base year. The datasets obtained including topographic, soil, geology, vegetation and human settlement were assembled. Satellite imagery acquired in over the area sourced from Google Earth map was used to investigate the extent of wetlands conversion. Field study became the primary tool to aid image interpretation process and essentially for the magnitude of wetlands deterioration and impacts over the area.

This paper utilized the United States Geological Surveys (USGS) landuse and landcover classification systems discussed by Anderson, et al (1976) which utilized landuse and landcover aggregates as basis for delineating the environment into classes and adapted by Fasona (2007) for the Ondo coast of Nigeria. The classification procedure for the Cameroon coastal wetlands adopted for the present study emphasized the broad embayment morphology of estuarine character where active sandy barrier beaches are obviously absent.

5. Results and impacts

The wetlands focused on in this study describe the Tiko-Douala wetlands which cover an area of 6,000 square kilometers to the Tiko end and 1,500 square kilometers in the Douala area giving estimated 7,500 square kilometers of coastal wetlands. The Landuse and Landcover characteristics of the area in 1976 and rate of changes from satellite imagery are shown in Table 1 and Table 2 respectively.

Table 1. Landuse/landcover analysis of the Tiko-Douala coastal wetlands of Cameroon in 1976

SN	Primary Class	Secondary Class	Area (km2)	Percentage
1	Water bodies	Rivers/Streams	250	3.3
		Canal	78	1.0
		Creeks	452	6.0
2	Wetlands	Salt marsh	625	8.3
		Mangrove	510	6.8
		Tidal flats	215	2.9
3	Natural Forest	Heavy forest	940	12.5
		Bush Thicket	660	8.8
4	Semi natural forest	Palm Swamp	1168	15.5
		Shrubs	332	4.4
5	Agricultural Lands	Farmland/Fallow	920	12.2
6	Built Up Area	Built Up Area	1050	14.0
7	Degraded Lands	Devegetated surfaces	200	2.7
		Bare surfaces	120	1.6
			7,520	100.0

Table 2. Landuse/Landcover analysis of the Tiko-Douala coastal wetlands of Cameroon

SN	Primary Class	Secondary Class	Area (km2)		Percentage	
1	Water bodies	Rivers/Streams	315		4.2	
		Canal	180		2.4	
		Creeks		526		7.0
2	Wetlands	Salt marsh	462		6.1	
		Mangrove	306		4.1	
		Tidal flats	140		1.9	
3	Natural Forest	Heavy forest	725		9.6	
		Bush Thicket		360		4.8
4	Semi natural forest	Palm Swamp		960		12.7
		Shrubs		155		2.2
5	Agricultural Lands	Farmland/Fallow	764		9.6	
6	Built Up Area	Built Up Area	1450		19.2	
7	Degraded Lands	Devegetated surfaces	389		5.2	
		Submerged areas	400		5.3	
		Bare surfaces		430		5.7
			7,562		100.0	

The large scale threats to the wetlands of the Cameroon coastal lowlands have been clearly displayed from the Tables presented above. Rapid urbanization and semi natural forests easily accounted for the greatest spatial extent of wetlands conversion and utilization as they revealed 1450 sq.km (19.2%) and 14.9% respectively, though palm bush swamp plantation dominates the latter with 960sq.km (12.2%). Human interference therefore play the major role in the conversion process, particularly for economic purposes of Raffia palm cultivation as this is evident in the reduction of agricultural lands coverage from 12.2% to 9.6%. It becomes obvious that the mangrove swamp forest received the largest scale of conversion over the area. Significantly, the palm bush plantation at the Tiko end of the wetlands continue to witness more encroachment as the people moved farther into the lagoon-creek system where farmlands are non-existent. Plantation activities are dominantly practiced by the Cameroon Development Corporation (CDC) on the better drained lands, while small stake holders and rural indigenous people of the area are those who steadily occupy the wetlands. The percentage coverage of the categories of wetlands in the study area reduced from 18% to 12.1% over a 20-year period. This trend would have been worse, but for the proliferation of the palm bush plantation which restricts human settlement.

The vulnerability of coastal wetlands to human-induced hazards is continuously observed in the ecological disruptions exerted on the land-water ecosystem. A clearly observable trend in the study area has been the continued susceptibility of the poorly reclaimed wetlands to perennial flooding. The rapidly built up areas of the Douala metropolitan area in the Bonaberi district evidently display flooding hazards. The Mabanda, Ndobo and Bonandale sub-districts of Bonaberi are constantly inundated for most parts of the year and here drains remain permanently stagnant. The consequence is widespread ground subsidence in these poorly reclaimed areas of tidal flats, lagoon-creek inlets where domestic refuse, industrial and solid wastes, and poorly sorted sands have been used as in-fill in reclamation. The annual prolonged wet season characteristic of this area is always a nightmare for residents as inundation, flooding and subsidence persists.

Water quality becomes increasingly impaired with far reaching health hazards. The industrial zone of the Bonaberi district of Douala built on the massively reclaimed wetlands is the seen of heavy discharge of industrial effluents on surface waters of adjoining localities of Mabanda, Bonassama, Ndobo and Bonandale. These effluents which are discharged during processing in form of solvents, fluids, sludge etc. into the aquatic terrain are easily moved over distances. As stated in an earlier study Asangwe (2006) of the Douala marine space, “these effluents contain enormous quantities of contaminants ranging from hydrocarbons to trace metals”. They all end up in this coastal environment of Douala that is very sensitive to deterioration, particularly of the aquatic terrain leading to contamination and eventual pollution of surface water with consequent health hazards to the people.

The Malaria vector is expected to proliferate with increased submerged areas which remain stagnant. Malaria

remains the most prevalent health problem in the Cameroon coastal lowlands.

6. Conclusions

1. Wetlands are fragile ecosystem particularly in the coastal zones where saline and freshwater environments ensure brackish nature with varying degrees of salinity, creating some of the most productive and diverse resources which are highly sensitive to human interventions.

2. Human intervention through reclamation and utilization has been on the increase in the rapidly urbanizing Douala metropolitan area due to scarcity of land.

3. The rate of wetlands conversion and methods utilized in reclamation has revealed clearly observable environmental problems that aggravate deterioration and degradation of the wetlands.

4. Inundation and flooding have become aggravated in the human settlement areas as more areas are devegetated and submerged. Management becomes increasingly difficult with ecological stress resulting from rising sea level.

5. Extensive knowledge of the Cameroon coastal wetlands is required for change analysis and this is most enhanced by landuse and landcover classification, complemented by fieldwork.

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